A SOIL SURVEY AROUND LANCASTER, PA.

By CLARENCE W. DORSEY.

INTRODUCTION.

During the field season of 1900 several months were spent in making a detailed soil survey of about 270 square miles in the principal tobacco-growing district of Lancaster County, Pa. In 1899, a large area in the Connecticut Valley in Connecticut and Massachusetts was surveyed, and maps were prepared showing the distribution of the various soils where the different types of cigar-wrapper leaf tobacco are grown. Lancaster County was selected as the oldest and one of the most important cigar-filler tobacco districts of Pennsylvania, and indeed of the United States.

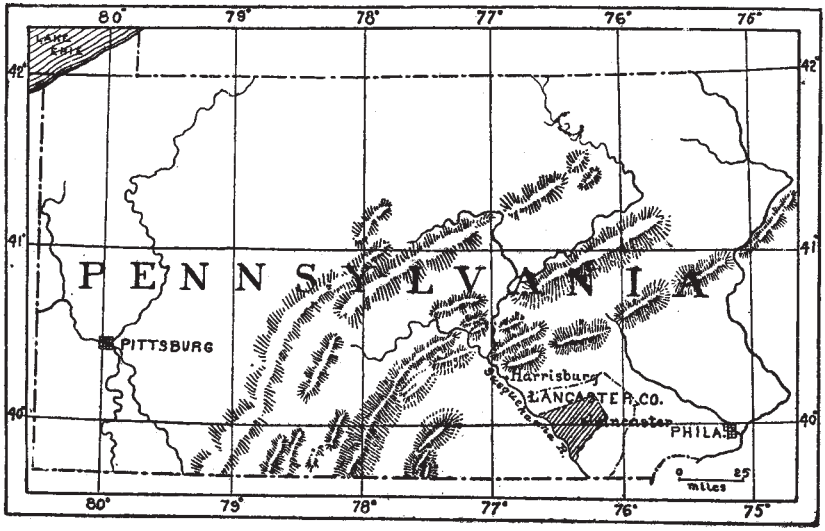


FIG. 1.—Sketch map of Pennsylvania, showing position of Lancaster County and area surveyed.

Lancaster County is situated in the extreme southeastern part of Pennsylvania. The Susquehanna River flows along the entire western border, while the southern part of the county touches Cecil County, Md. It is one of the large counties of Pennsylvania, its area being, approximately, 970 square miles. The fortieth parallel passes through the south-central part, and the greater portion lies between 76° and 76° 30″ west longitude. It was early settled, and for a long time has ranked as the foremost agricultural county of the State.

That part which was surveyed lies in the west-central portion of the

county (see fig. 1), with the Susquehanna River along the western border, Lancaster, the county seat, being in the central part of the area.

TOPOGRAPHY.

The beautifully diversified surface of the country is the result of the unequal weathering and erosion of the rocks which are found there. Rocks which weather rapidly, such as limestones, have formed the broad rolling valleys which constitute so pleasant a feature of the landscape. Other rocks, composed of materials which have more successfully resisted the wearing down processes of erosion, now form prominent ridges running across the county and the more hilly portions found along Pequea and Conestoga creeks. Generally speaking, the surface of the country consists of wide valleys, ranging in elevation from 350 feet to 400 feet above sea level, broken by long ridges which rise from 100 to 250 feet above the general valley level.

The broad limestone valley, in the center of which Lancaster is located, is broken by a prominent sandstone ridge which traverses the area. This rises abruptly from the river just north of Columbia, and continues in an easterly direction as a prominent ridge until about 5 miles northwest of Lancaster, where it becomes broken and appears only as scattered hills. Another prominent ridge, about 1 mile south of Lititz, rises considerably above the limestone valley and continues unbroken across the northern part of the entire area.

South of Columbia are prominent ridges extending in an easterly direction until they merge into the sandstone ridge described above. In the southern part of Conestoga and Pequea townships are hilly stretches of country, which rise to an elevation of probably 500 feet above sea level.

The Susquehanna River traverses the entire western border of the area surveyed. It varies in width from one-half to slightly over one and one-fourth miles. Where the river comes in contact with limestone rocks the country slopes gradually back to the broad valleys; where the sandstones and the older crystalline rocks are found the river has high, steep, heavily wooded banks, which rise to a considerable elevation. The entire area is well watered by a great number of small streams. The main streams, which carry away the greater part of the rainfall, are the Conestoga, Little Conestoga, Pequea, and Chiquesalunga. All of these creeks flow in a southwesterly direction and empty into the Susquehanna. The various streams furnish abundant water power, which is utilized to a great extent by numerous mills for grinding wheat and corn. The streams are dammed at frequent intervals, and practically all of the flour and paper mills in the county are run by water power. Nearly all of the mills are old, some of them having done service for more than a century, and, judging from their substantial appearance, are fully capable of another century's service before their day of usefulness is ended.

GEOLOGY.

In Lancaster County the soils are, with but few exceptions, the result of the disintegration and decay of the various rocks which occur there, so that a close connection is seen between the soils and rocks of the country. It is found that the limestone valleys are always characterized by soils which have certain features in common, while the soils of the sandstone and shale ridges always partake largely of the nature of the rocks from which they are derived.

The rock formations belong to four great geologic divisions. The first division covers the old metamorphic series of rocks, comprising in the area surveyed the chlorite and mica-schists of the lower townships along the Pequea and Conestoga creeks. Comparatively little is known of the origin of these rocks, as the changes which have taken place in them, caused by the alteration processes through which they have passed, are complex and manifold.

The second group of rocks found in the county embraces the limestones and sandstones, sedimentary rocks whose origin and age are definitely known. It is from these, and especially the former, that the richest agricultural lands are derived. These rocks are all sedimentary deposits which have also undergone changes due to the processes of metamorphism since they were deposited, but the changes have not been so marked as in the rocks just referred to.

The third great division is represented by the steep shale hills which traverse the area several miles north of Lancaster. The belts of igneous trap rocks or "iron stones" also belong to this series of formations.

The fourth class of rocks found in the area represents the series of gravels and sands found as terraces along the Susquehanna River and a few of the larger streams. These deposits belong to a much later geological period than any of the above. These four classes of rock deposits are commonly referred to by geologists, naming them in the order given above, as Archæan, Paleozoic, Mesozoic, and Cenozoic, these names referring to the character of animal and plant life which existed at the time the rocks were formed, except the Archæan, which is characterized by the absence of either plant or animal life.

The various rock formations of this portion of Lancaster County furnish many valuable and useful deposits. The Paleozoic limestone beds furnish large quantities of fine stone suitable for building purposes, material for roadways, ballast for railroads, and material well adapted for making lime. There are small deposits of marble in some parts of the county, but the quality and extent of the deposits have never been fully investigated. Sandstone or quartzite furnishes some building stone, and when crushed makes a fine sand suitable for the manufacture of glass. The terraces along the Susquehanna furnish good building sand and gravel for road ballast. Formerly there were

several rich iron mines, but of late years many of these have ceased to be operated. The most extensive iron mines now in operation are situated near Silverspring.

CLIMATE.

During the growing season it is much hotter in Lancaster County than it is in the northern and western parts of the State. This is due to the fact that the average elevation above sea level of Lancaster County is much less than in the northern and northwestern parts of the State. The proximity to large bodies of water also exerts considerable influence.

The following table, published in the Annual Report of the Pennsylvania State College for 1898–99, shows the mean annual temperature and rainfall for the growing season:

Mean annual temperature and rainfall.

Month.	Mount Joy.		Ephrata.	Lancaster.
	Mean temperature (16 years).	Mean rainfall (11 years).	Mean rainfall (8 years).	Mean rainfall (4 years).
	° *F.*	*Inches.*	*Inches.*	*Inches.*
April	52	3.33	4.38	4.22
May	63	3.74	4.68	3.11
June	73	3.84	4.58	3.75
July	77	3.25	3.96	2.83
August	74	4.38	5.61	3.85

The mean maximum temperatures for this section of Pennsylvania are: April, 61°; May, 71°; June, 81°; July, 84°; and August, 81°. The mean minimum temperatures are: April, 40°; May, 49°; June, 60°; July, 64°; and August, 61.° The mean daily ranges of temperature are: April, 21°; May, 22°; June, 22°; July 21°; and August, 22°. The mean annual rainfall is 44 inches. The southern part of the county is said to have a slightly greater amount of rainfall than the annual average just given, but figures are lacking to substantiate this statement. The autumns are always late in Lancaster County and it is said that tobacco planted as late as July is seldom caught by frosts, which rarely occur before October.

HISTORY AND EARLY AGRICULTURE.

According to the old histories and records, when Lancaster County was first settled, in 1709, it presented an appearance quite unlike the present. The few scattered tribes of Indians living in this section at the time were not the original tribes, but remnants of tribes that had been driven out of Maryland, Virginia, and the Carolinas. They lived by hunting and fishing and by carrying on a primitive system of agriculture, the squaws raising small crops of corn and beans. The

methods of agriculture were primitive. They first girdled the trees and burned them, then scratched the ground with crooked sticks and planted their crops; later they cultivated the growing crops with shells and sharp stones. In the fall the cornstalks and weeds were scraped together and burned. This killed all the young saplings except the hardier scrub oaks. These latter, after being repeatedly burned, formed thick, knotted clumps of roots. Such areas the early settlers called "grubensland." At the time this section was settled there were several of these Indian fields, one being just west of Lititz.

With the exception of the few scattered Indian fields and occasional swamps and meadows, the country was densely forested. This was especially the case in the limestone valley. On the sandstone ridges the timber was not quite so abundant. On the heavy limestone soils the forest consisted of a thick growth of ash, elm, hickory, walnut, and several varieties of oaks, all being indicative of a deep, rich soil. On the sandstone and slate ridges the forest trees were not so large, but were tougher and included more varieties. These ridges were the native home of the chestnut.

The Mennonites, who emigrated from Switzerland and the Palatinate, were the first white settlers in what is now Lancaster County. They came in 1709, and advanced as far as the Conestoga. Shortly after them followed the French Huguenots, who settled in the Pequea Valley, emigrating from the departments of Alsace-Lorraine. The Huguenots were in turn followed by the Scotch-Irish, who settled on Chickies Creek in 1715. Other settlers followed in rapid succession, including the Welsh Episcopalians, Quakers, Dunkards, and Lutherans.

The Scotch-Irish settled in the more hilly portions, because the lighter timber of the stony ridges was more easily cleared and the country somewhat resembled their native homes. The Swiss and Germans, however, who keenly appreciated the value of wood from the severity of the forest laws in Europe, selected for their farms the richest meadows and heaviest tracts of timber in the limestone valleys, reasoning that where the timber was heaviest there the soil must be richest. There are some, however, who maintain that the Germans and Swiss, the noncombatants, were assigned to the valleys, while the Scotch-Irish, naturally fighters, were encouraged to settle on the hills, where they might first come in contact with the Indians or other enemies.

Much has been written of the hardships and struggles of the early settlers. They cleared small tracts of land with great labor, and portions of the natural meadows were staked off. Crops of oats, corn, barley, and buckwheat were cultivated for summer crops, and rye was the main winter crop. Spelt was grown in place of wheat, as the latter was considered too delicate to be grown in this section. Flax and hemp were soon introduced.

As the natural meadows were the only places where hay was grown, these were enlarged by damming the small streams and flooding the meadows at certain times. In the early title deeds to the farms the rights to water for irrigation purposes were clearly set forth. The use and control of the stream were given to the owners of the several tracts of meadow land for a certain number of days in each week. In about the year 1800 timothy and red clover were introduced, and it was found that these crops could be grown on the uplands, so the meadows were no longer so necessary to furnish the hay crops. Remnants of the old dams can still be seen along many of the small streams.

A few years later wheat was introduced, which gradually superseded spelt and barley as grain crops; improved machinery for use in cultivating and harvesting crops were introduced; large Swisser barns and substantial limestone houses were built, and the country began to assume much its present appearance.

AGRICULTURAL CONDITIONS AND STATISTICS.

Lancaster County is preeminently an agricultural county. It is a county of well-kept, carefully cultivated farms, which attest the thrift and industry of the many generations of farmers who have lived there since the early part of the eighteenth century. From one of the many ridges which traverse the county it is seen to be thickly settled for a farming district. Often, on a clear day, as many as 50 farms may be counted, all having the large barn, dwelling house, tobacco shed, windmill, and other buildings with which every farm is supplied.

The farms vary in size from a few acres to 200 acres, the average size being about 80 acres. This is considerably less than it was twenty years ago, for during that period there has been a constant decrease in the size of the farms. These farms, in addition to other improvements, always have large barns. They are usually patterned after the Swiss barns, those most complete having a granary on the upper floor, wagon sheds, cornerib, sheds for horse power, thrashing floors, hay mows and lofts, as well as stables and feeding passages in the basement. Under the driveway there is also a cellar, and frequently a tobacco shed is attached. They are substantial structures, the lower parts being built of limestone and brick, with the upper stories generally built of wood and painted red. A good barn of this kind costs in the neighborhood of $4,000, and many are seen which cost as much as $6,000.

The dwellings are well built, comfortable houses of brick or limestone, although they are not quite so pretentious as the barns described. Two thousand five hundred dollars probably represents the average cost of the dwellings, while a good tobacco barn will increase the cost of improvements about another thousand. On the larger farms a tenant house is usually found, which still further increases the amount

of money necessary to equip a good farm. These amounts, added to the cost of substantial fences, smaller buildings, and sheds, make the total cost of improvements a large amount. Still these improvements are always found on the Lancaster County farm of 80 or 100 acres. A characteristic group of farm buildings is shown in Pl. I.

Even without improvements the price of farm land is high in the county, and it is seldom that a well-improved farm in the central portion sells for less than $125 per acre, the price often being from $200 to $300, or even higher within a few miles of Lancaster.

The principal crops grown at the present time are grass, wheat, corn, oats, rye, and tobacco, as well as potatoes, small fruits, and truck for the local markets. All of the crops, with the exception of tobacco, are consumed or manufactured within the county. Instead of hay and grain being shipped out of the county, large quantities of feed are each year brought in and used for fattening cattle. Little or no commercial fertilizers are sold in the county, but special effort is constantly made to increase the productiveness of the land by liberal applications of well-rotted stable manure. As a result, the soils, it is stated, produce far more than they would even a few years ago.

In addition to the crops already mentioned, large quantities of fruit are grown. While there are no large orchards, nor is any special effort made to develop the fruit industry, still every farm is supplied with a few trees, including apples, peaches, pears, cherries, and occasionally apricots, and in the aggregate thousands of bushels of such fruits are annually grown in Lancaster County in addition to grapes and various small fruits.

The tobacco crop is counted on as the main money crop, and many farmers pay the expenses of the farm with the other crops, while the money derived from the sale of tobacco is clear profit. It certainly brings a great deal of money into the county and furnishes employment to a large number of people.

The central portion of Lancaster County is well supplied with railroads, which afford ample means of transportation to Philadelphia and Baltimore markets. In addition to the splendid railroad transportation facilities, many electric car lines have been constructed within the past few years between the principal towns, and others are contemplated. Good limestone pikes lead out in every direction from Lancaster, and these are connected at frequent intervals by fair dirt roads. The toll system is relied upon to keep the pikes in repair. The toll for a one-horse buggy is 2 cents per mile; for a two-horse team, double this amount.

SOILS.

In the 270 square miles of Lancaster County which were surveyed, 11 different classes of soils were recognized and their boundaries outlined on accurate, large-scale maps. Topographic maps were not

available for this work, but the maps used were those prepared for the county commissioners and were found to be exceedingly accurate, so that no difficulty was experienced in locating the soil boundaries.

This section of Pennsylvania is south of the area covered by the ice during glacial times, so that the soils here are, with but two exceptions, the decomposition products of the rocks which are found there. The names adopted for the various soil formations are those of similar soil formations elsewhere or local names which have been selected from the names of creeks or townships.

The different soils have about the following areas:

Areas of the different soils.

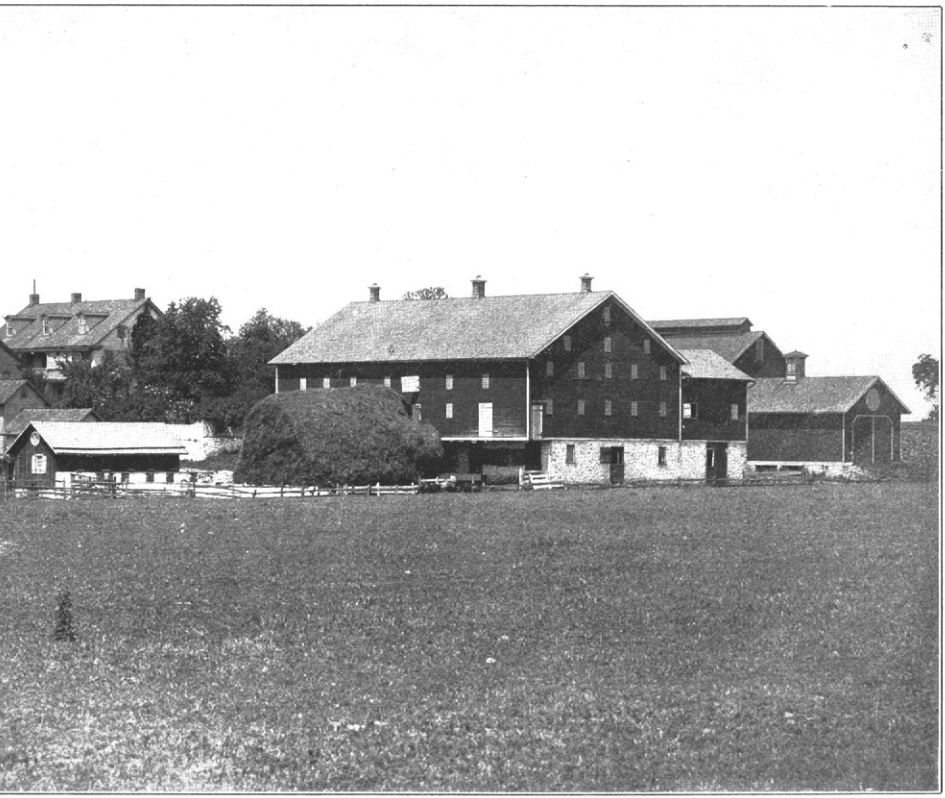
Soils.	Acres.	Per cent.	Soils.	Acres.	Per cent.
Conestoga loam	51,000	29.5	Meadow	6,000	3.4
Hagerstown loam	45,000	26.0	Donegal gravelly loam	4,000	2.3
Hagerstown clay loam	21,000	12.1	Manor stony loam	3,500	2.0
Hagerstown shale loam	15,000	8.6	Hagerstown clay	2,000	1.1
Edgemont stony loam	13,000	7.5	Hempfield stony loam	1,400	.8
Cecil mica loam	10,000	6.1			

HAGERSTOWN LOAM.

Large unbroken areas of this formation occur in the townships of East Hempfield and West Hempfield, Rapho, and East Donegal. The surface is gently rolling, rising from 350 to 400 feet above sea level. There are no marked changes in elevation, but a succession of long, sloping ridges and broad, rounded hills.

The soils of this formation are the residual decay products of massive beds of blue limestone, which were deposited during late Cambrian and early Silurian times. The soils are merely the insoluble portion of the rock which have remained after the lime has been removed in solution, mixed perhaps with the more sandy layers which are occasionally interbedded with the limestone. A feature of the limestone areas here, so common in all limestone countries, is the large number of sinkholes which bear testimony to the manner in which these rocks are honeycombed and dissolved away by percolating rain waters. The Hagerstown loam is well drained and at the same time well watered by scores of small streams. Rain water readily enters these soils, and cases of washing on the slopes, so common in the Southern States, are quite uncommon here.

The soils are yellowish-brown mellow loams, containing a fair proportion of clay. They are from 8 to 12 inches deep and contain a goodly share of organic matter derived from liberal applications of manure, which they receive at least every four or five years. These soils are rich and productive and seldom fail to make good crops of corn, tobacco, wheat, and grass. The subsoil contains less organic matter and a greater proportion of clay, and may be classed as clay



OUP OF FARM BUILDINGS IN THE LIMESTONE VALLEY OF LANCASTER COUNTY.

loams. These are generally of a decided yellow, although they may locally be spoken of as red clay. At an average depth of 24 inches the yellow-clay loam grades into a stiff red clay. The exact depth of the clay subsoil varies greatly in different localities, owing largely to the character of the limestone occurring in any particular place. Occasionally the harder beds of limestone may protrude from the ground, but more often they are buried from 3 to 20 feet below the surface. While there may be some trace of cherty limestone or sandstone fragments found on the surface, still there is never a sufficient quantity of large bowlders to seriously interfere with cultivation. These soils are always spoken of as limestone soils and are classed as rich, fertile soils, which bring good prices when well improved. The local differences in the soils are slight. Frequently the brown loam may be deeper at the foot of a long slope, where it has accumulated, while in other places the yellow-clay loam subsoil may continue to a depth of 3 feet before the stiff red clay is reached.

The following table gives the mechanical analyses of typical samples of soils and subsoils of the Hagerstown loam formation:

Mechanical analyses of Hagerstown loam.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4952	Mechanicsburg, 2 miles E.	0 to 12 inches...	4.63	2.02	3.28	3.25	6.50	11.92	54.28	14.17
4953	Subsoil of 4952.....	12 to 36 inches..	3.19	1.29	1.75	1.84	4.13	10.58	49.57	27.66

The heavy timber growth, described as characteristic of the limestone valleys when the country was first explored, was found on these soils. But little now remains of the once mighty forest. Occasionally a few acres of woodland may be found or some scattered trees in the fields, but they are all that is left of the thick growth of hickory, walnut, and mammoth oaks. The original timber was cut many years ago, and even the small wood lots are rapidly disappearing.

The Hagerstown loam ranks high as fine corn, tobacco, wheat, and grass land. It is best suited to corn and tobacco, although all of the crops mentioned are grown with success. In 1900 the wheat crop was said to have averaged from 20 to 35 bushels per acre, and in a good year from 75 to 80 bushels of corn per acre can be raised. Oats succeed well and make large yields, but they are not grown as extensively as they formerly were. This soil produces a fine filler leaf tobacco, but attempts at growing a wrapper leaf have failed. The leaf is

large and thick, has a dark color, and thickens considerably in the sweat. In good years, by proper manuring, from 1,500 to 2,200 pounds of tobacco can be raised on an acre. Tobacco is seldom planted on the same field year after year, but has a place in the regular rotation. Generally it follows the grass crop or is planted on corn ground.

Most of the common fruits succeed well, with the exception of peaches. Many of the fine farms of the country are situated on this formation, and they are all carefully managed by a prosperous class of farmers.

HAGERSTOWN CLAY LOAM.

The Hagerstown clay loam occupies less than one-half the area of the formation just described, the greater part being found in the townships of East Lampeter, Upper Leacock, Manheim, and Warwick. The character of the surface of this formation is quite similar to that of the Lancaster loam—broad, rolling valleys, with gently sloping ridges and low, rounded hills. Along the creeks there are steep hills, through which ledges of limestone protrude, but these form the only contrast to the broad, rolling stretches of country. These soils are likewise derived from the decomposition of thickly-bedded limestone containing occasional thin layers of sandstone. The remarks made concerning the drainage conditions of the Hagerstown loam apply with equal force here.

The Hagerstown clay loam is much heavier than the Hagerstown loam, containing a greater percentage of clay. The soil usually consists of about 10 or 12 inches of a dull reddish-brown clay loam underlaid by stiff clay loam of the same color. At 24 inches a stiff red clay similar to that under the Hagerstown loam is found, and this continues to a depth of several feet. There is a trace of broken, angular quartz fragments on the surface, with occasional pieces of sandstone. The amount of quartz or other rock on the surface rarely exceeds 25 per cent, and is generally less than 10 per cent. These soils are locally called red-clay limestone soils, and were originally covered with a heavy timber growth which has long since been removed. The entire extent of this formation is carefully farmed. Wheat succeeds exceptionally well, and these lands may be considered the best wheat lands of the entire county. From 20 to 40 bushels per acre can be grown. Good crops of grass can also be grown on these soils, and from $1\frac{1}{2}$ to 2 tons of hay per acre may be said to be a fair crop. The practice is to sow timothy and clover seed mixed, but the clover rarely lasts more than one year. Corn and oats do well on these soils, but it is not a typical soil for corn, being stiffer, firmer, and not so mellow as the lighter loams of the formation just described. The usual rotation practiced on these soils is to follow corn with oats, potatoes, or tobacco, then wheat, after which the field is seeded to grass. The grass is allowed to remain two years. This

LOAM VALLEY WITH EDGEMONT STONY LOAM ON THE RIDGE IN THE BACKGROUND.

rotation is varied somewhat according to the number of fields in the farm.

Lime is generally applied during the rotation, or once in every four or five years. Some commercial fertilizers have been applied to these soils, mainly phosphates, but these are said to burn out the soil in a few years, so that their use is not generally recommended. Most of the farms in this formation have a small field of tobacco each year, but the soil is not ideal for tobacco. Yields as large as from the Hagerstown loam are reported for these soils, but they are recognized as being too stiff and clayey for the best results with tobacco. Seed leaf is mostly grown on these soils. This is essentially a filler tobacco, although there is a small percentage of each crop used for wrapper and binder purposes. Attempts at growing Havana seed have generally proved unsuccessful. Farms on the areas of this formation are considered equally as valuable as those on the Hagerstown loam, and, for a farmer who does not wish to grow tobacco, they are worth perhaps more, because, being stronger, they can more successfully stand hard farming.

Mechanical analyses of representative samples of this formation are given in the following table:

Mechanical analyses of Hagerstown clay loam.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4962	Binkley	0 to 10 inches	5.50	1.01	2.63	2.51	6.40	9.98	58.64	13.64
4966	Landis Valley	0 to 9 inches	5.67	1.81	1.72	1.15	2.41	5.95	65.69	16.06
4967	Subsoil of 4966	9 to 38 inches	6.04	2.84	1.96	2.50	4.98	8.98	47.79	24.44
4963	Subsoil of 4962	10 to 36 inches	4.10	2.16	2.38	2.26	5.17	10.22	46.77	27.14
4961	Witmer, one-third mile NW.	Red-clay loam, 10 to 30 inches.	4.30	2.06	1.75	1.08	1.91	8.48	53.24	27.55

HAGERSTOWN CLAY.

In the area surveyed this formation does not cover more than 2 square miles. The largest areas occur in Manheim township, a few miles northwest of Lancaster. This formation forms part of the broad valley, and is likewise derived from thick beds of comparatively pure limestone of Cambro-Silurian age.

Although this formation is like the Hagerstown loam as regards occurrence and origin, yet the general appearance and texture are very different. These soils may be said to be the Hagerstown loam from which the top covering of loam has been removed, exposing

the clay subsoil, and yet these soils do not occupy positions where erosion is more pronounced than in the case of the first two formations described. However their clayey nature may be accounted for, they are stiff, heavy clay soils, with no trace of the covering of lighter loam. The soil to a depth of 12 inches is a heavy red loam, stiff and tenaceous, overlying a heavy red clay. These soils are generally comparatively free from quartz and sandstone fragments, but, on account of the large amount of clay they contain, are difficult to cultivate. They produce fair crops of corn and tobacco and good crops of wheat and grass. They are well adapted to wheat and grass, but they are too stiff to be generally sought after for general farming. In a dry season they bake and form great clods not easily broken, while in a wet year they dry slowly. Tobacco does not succeed at all well on these soils, as they are too stiff and intractable, and a poor growth is the result. The areas of these soils are so small that it is hard to form an adequate estimate of the value of these lands.

The mechanical analyses of a few samples of the Hagerstown clay soils and subsoils are given in the following table:

Mechanical analyses of Hagerstown clay.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4968	Lititz, one-half mile NE.	0 to 10 inches	6.91	1.10	1.14	0.74	2.93	12.98	61.41	13.94
4970	Petersburg, 1 mile E.	0 to 12 inches	4.48	1.68	2.31	1.70	4.73	10.61	56.02	18.48
4969	Subsoil of 4968	10 to 30 inches	5.45	.14	1.02	.84	2.66	8.56	47.77	33.47
4971	Subsoil of 4970	12 to 30 inches	5.07	1.93	1.26	.70	1.93	6.25	38.36	44.63

MEADOW.

Meadows occur as narrow strips along the greater part of the small streams found in the entire area. They seldom exceed one-fourth of a mile in width, but they are such a persistent feature of the small streams that their boundaries were outlined on the map, even at the risk of being exaggerated in a few cases. These are natural meadows, and many of them in the early days were enlarged by damming the small streams, and were used to supply the entire hay crop. At present they are rather insignificant from an agricultural standpoint, although the name "meadow" still clings to them. They occur, typically developed, in the limestone valleys, but are found even in the more hilly portions of the county. They are derived partly from materials carried several miles by the streams and partly from the washings from the neighboring hillsides. Generally there is a large

amount of organic matter contained in these soils, so that to a depth of 12 inches the soil consists of black, heavy loam, grading into a heavy sandy loam resembling muck, or, as in some localities, into a wet, blue clay. The meadows are low, wet, poorly drained, and in their present state not generally cultivated, although some portions which are better drained produce fair crops of timothy hay and corn. Wheat makes a heavy growth of straw, but the heads seldom fill well. Clover does not succeed on these meadow lands. Generally, the meadows are left to furnish pasture for cattle and horses, and for this they are admirably adapted. While the strips of meadow land are narrow, no large areas being found, still the combined areas of the meadows amount to several square miles.

CONESTOGA LOAM.

This formation occupies the largest area in the central portion of the county. It comprises the greater part of East and West Lampeter, Lancaster, and Manor townships, besides the northern part of Pequea and Conestoga, as well as the northern part of East Hempfield. It extends in an unbroken area from near the Susquehanna River, in Manor Township, directly east to Pequea Creek. This area occurs as a broad limestone valley, but it is distinctly different from the limestone valley which is formed by the combined areas of the three formations described above. The hills and ridges which are found in this area are distinctly higher and steeper than in the region to the north of Lancaster. The largest creeks of the county are found in this formation, namely: The Conestoga and Little Conestoga creeks, Mill Creek, and, on the southern border, Pequea Creek. As these creeks traverse the area of the Conestoga loam, they are all characterized by long, winding courses. This is noticeably the case along the southern border of Lancaster city, where the Conestoga makes a series of long, sweeping curves, which form a pleasant feature of the landscape about Lancaster. Frequently these curves are over a mile in length, with narrow, rocky hills between them. Along all of the streams in this area the banks are rough and steep, with projecting ledges of limestone. A good illustration of the more rolling character of this formation, as compared with the other limestone areas, is seen in the fact that the main line of the Pennsylvania Railroad follows along the northern border of the formation rather than going directly through it, which the more direct course would suggest.

The soils of the Conestoga loam are also derived from the residual decay of limestones, but they are not massive limestones, as those found north of the city of Lancaster. On the contrary, the beds of limestone are much folded and metamorphosed, and beds of schistose limestone and veins of calcite of considerable size are frequently seen. The thicker beds of limestone are much rougher in appearance

than are the massive limestones found north of Lancaster. They are locally called sandy limestones, but on close examination they are found to contain no trace of siliceous materials. The soils derived from the weathering of these limestones are seldom as deep as the Hagerstown formations. This is probably due to the character of the rocks from which they are derived. Sink holes, which are common in the limestone valleys north of Lancaster, are not found here. Not only are the larger streams abundant in this formation, but there are a great number of small streams, showing that the greater part of the rainfall runs off in superficial streams rather than in underground channels.

The soil to a depth of 10 inches closely resembles the soil of Hagerstown loam. It is a yellowish-brown loam, mellow, easy to cultivate, and generally contains less quartz fragments and other stones than does the Hagerstown loam, clay loam, or clay. Often there is a trace of broken bits of thin, schist-like rock, ranging in diameter from one-half inch to 2 inches. In many localities the soils have a greasy look, are much lighter in color, and when crumbled between the fingers have a distinctly greasy or soapy feel. This is a property seldom noticed in soils, no matter what their origin may be. It is probably due to the dissemination of exceedingly fine particles of mica (sericite) through the soil. The subsoil, from 10 to 30 inches, consists of a light clay loam of a yellowish color, always possessing the characteristic greasy feel of these soils. At an average depth of 30 inches the subsoils grade into a dark-colored mass of greasy, decomposed schist having a cool, moist feel. Such soils are always well drained unless in low positions, and are therefore warm and dry. They are quite early in the spring on this account, but a long dry season is apt to affect crops late in maturing. They are often spoken of as sandy limestone soils, well adapted to corn and tobacco and other crops which require a light, loamy soil. They are not as strong and productive as the soils which are underlaid by stiff clay subsoils. They make good general farm lands, however, and are as eagerly sought after as the best soils of the county. Twenty-two bushels of wheat per acre is considered a fair average, although even 40 bushels are grown in good years, while from 60 to 80 bushels of corn can be raised on an acre if the season be favorable. Tobacco does well on these soils. It can be planted earlier than on the other limestone soils of the county. A large part of the Havana seed tobacco for cigar wrappers is grown here. The trouble with fleas and worms is not so great and the soils are better adapted to the growth of a thin, elastic leaf suitable for wrapper and binder purposes. From 1,400 to 1,600 pounds of Havana seed and 1,600 pounds of seed leaf are considered good average yields on an acre of land. When the crops of Havana seed tobacco are harvested in good condition they bring much better prices as wrappers than that paid for the average Pennsylvania seed, but

with the diminished yield and greater risks to be borne it is doubtful if growing tobacco on these soils for wrapper purposes is very profitable.

In the following table the texture of typical soils and subsoils of this formation is given:

Mechanical analyses of Conestoga loam.

No	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4976	Soudersberg, one-half mile SE.	Dark loam, 0 to 10 inches.	5.40	0.60	1.44	1.16	7.04	19.96	57.37	7.56
4972	Bausman, 1¼ miles SW.	0 to 10 inches	5.95	3.77	2.82	1.87	9.34	22.21	41.86	12.55
4977	Subsoil of 4976	Light clay loam, 10 to 30 inches.	3.06	Tr.	1.52	.85	5.98	23.08	54.64	10.87
4973	Subsoil of 4972.....	10 to 30 inches	2.84	1.96	3.66	2.76	10.94	27.91	34.30	14.54

EDGEMONT STONY LOAM.

The greater part of the area of Edgemont stony loam is found in the townships of West Hempfield and East Hempfield. There are also small areas in Manor, Manheim, and Upper Leacock townships. These areas are all considerably above the general valley level. The greatest elevation is probably above Columbia, where the Susquehanna has notched the sandstone ridge, forming steep, rocky bluffs on both sides of the river. The elevation along this ridge is in the neighborhood of 200 feet above the valley. This ridge continues unbroken to Rohrerstown, where it terminates in a large, rounded hill. About 4 miles north of Lancaster it is found again occurring in short ridges and bold, rounded knobs. All of these ridges and chains of steep knobs extend in an easterly and westerly direction.

These soils are derived from the decay of a fine-grained, siliceous sandstone or quartzite of Cambrian age. The rock is composed of quartz particles firmly cemented together and well calculated to resist the wearing-down influences of atmospheric decay. For this reason the areas of this rock stand above the valley level. Rocks which decompose as slowly as these are seldom covered with a thick layer of soil. So soon as the weathering influences set free the fine particles of sandstone they are carried away by the rains, so that a considerable thickness of soil is not allowed to accumulate. This is especially noticeable on the steeper slopes where the soil covering consists of only a loose mass of sandstone fragments mingled with a slight amount of sand and decomposed organic matter. On some of the broad, flat-topped hills of this formation, where the influence of washing is not so

marked, a thicker covering of sandy soil is found. The soil rarely exceeds 20 inches in depth and generally is much shallower. Little difference is seen between soil and subsoil. The average soil section in this formation is from 6 to 8 inches of a brown, sandy loam, more or less stony, which grades into a loose mass of sandstones and slates. The surface soil is thickly strewn with angular pieces of flat, flaggy sandstone varying in diameter from 1 to 10 inches. The amount of stones on the surface varies from 30 to 60 per cent. The subsoil, when the soil covering is sufficiently deep to have a subsoil, consists of yellow, sandy loam filled with sandstone fragments. As would be expected, these soils are not strong nor productive, but crops grown upon them possess a quality far superior to that of the more fertile limestone soils. Fruit grown on these soils has a fine flavor, and in some localities, as at Fruitville, raising berries and small fruits has become quite an industry.

Many successful peach orchards are also seen on the stony lands of this formation. It is upon stony hillsides of this same soil formation that the mountain peach industry has been so successfully developed in Maryland, and, judging from the success attained in small ventures in raising peaches and small fruits in Lancaster County, there seems no reason why the fruit industry should not reach proportional dimensions. The greater part of these ridges is covered with a forest growth of chestnut, locust, and several varieties of oak. On the cleared areas corn, oats, rye, and potatoes are mostly grown. The quality of these crops is always good, but the yield is small. Wheat does fairly well on these soils, in that bright, heavy grain is produced, but the yield is small. They are considered good lands for "hill lands," but they are difficult to cultivate, and require a considerable outlay to make them productive. They are locally known as gravel soils.

In the table following the texture of a few typical samples are compared. They are much lighter than the Hagerstown loam.

Mechanical analyses of Edgemont stony loam.

[Fine earth.]

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4981	Columbia, one-half mile W.	0 to 10 inches	3.78	2.79	7.03	11.02	25.20	27.52	19.16	2.49
4980	Neffsville, 1 mile SE.	0 to 10 inches	14.76	6.80	2.84	3.93	7.56	23.06	38.98	2.61
4979	Mechanicsburg, 1 mile W.	Brown, stony loam, 0 to 12 inches.	3.11	7.92	2.78	2.20	5.28	31.42	40.60	5.72
4982	Subsoil of 4981	10 to 28 inches.	2.28	6.74	8.24	5.20	20.52	24.53	20.79	11.71

HARACTER OF THE SOIL OF THE EDGEMONT STONY LOAM FORMATION.

Tobacco has not been grown on these gravel soils to any great extent, but it has long been recognized that they produce a fine quality of tobacco, which approaches more nearly to the style of tobacco now in demand for a cigar wrapper than does the tobacco grown on other soils in this area. It is light in color, thin and silky, and with proper care and treatment would probably make a good wrapper leaf. At present, however, it brings but little more in price, while the yield is considerably less than on the limestone soils, so that these soils are not considered good tobacco soils. They will seldom produce more than 1,200 pounds per acre, and will produce this amount only by heavy manuring. South of Neffsville there is a piece of land so stony that the soil appears to be nothing but a loose mass of stones, yet fine crops of tobacco have been raised on this field for twenty-five years in succession. This certainly shows that there are possibilities in these soils which have not been fully realized.

Few if any large farms are situated on this formation, and the land commands a much lower price than in the formations just described.

HAGERSTOWN SHALE LOAM.

The area of the Hagerstown shale loam is slightly larger than that of the last formation described. It covers two areas of considerable size. One begins just north of Mount Joy, in Rapho Township, and continues unbroken in an easterly course across Penn and Warwick townships. The second large area occurs just north of Lititz, surrounding the village of Brunnerville. There are also small areas of this formation situated in East Hempfield Township. The surface features of these areas resemble somewhat those of the Edgemont stony loam just described. (Pl. II.) They are high, rounded ridges rising to a considerable elevation (100 feet or more) above the general valley level. These hills and ridges are symmetrically curved and rounded, and form a more pleasing feature of the landscape than do the bold, steep hills of the formation just described. The soils are derived from the disintegration of fine-grained shales of Mesozoic age. They form a part of the series of Triassic shales and sandstones which traverses so many of the Eastern States from New England far into the Southern States.

These rocks were deposited as fine-grained sediments in comparatively shallow seas. Since they were laid down they have undergone some changes, and appear as thin beds of shales which resist erosion so much better than the limestone that they form ridges and hills. The soils derived from these shales are fine yellowish loams filled with bits of broken shale. In places the soil is merely a mass of loose shale fragments, shallow, easily drained, and suffering greatly from drought in dry seasons. They seldom exceed 18 inches in depth, and generally they are not over 12 inches deep. On the surface the char-

acteristic shale particles are scattered, the particles being rarely more than an inch in thickness although they may be many inches in length. They constitute from 20 to even 60 per cent of the top 8 inches of soil. Such soils wash badly, and on the steeper hill slopes great furrows or gullies may be noticed which, unless soon checked, widen perceptibly from year to year. These soils are also called "gravel lands," and in their natural condition ranked very low as farm lands. Thirty or forty years ago they were hardly cultivated at all, but were allowed to grow up in mullein and other weeds. It was not considered that they would produce much of anything, but were used as short pastures which dried up at the approach of hot weather. Since then, however, by means of frequent applications of manure and by careful cultivation they have been made fairly productive. They are said to produce about 25 per cent less than the Hagerstown loam. Fruit succeeds fairly well on such soils, but there has been no special effort to develop the industry. The remarks made about the crop conditions of the Edgemont stony loam apply with equal force here. The yields are light but of good quality. Corn, oats, rye, clover, and wheat are grown on the cleared lands, but many large forested areas remain. Chestnut trees abound largely in the forests. Tobacco grown on these soils is thin, light-colored, fine-textured, better adapted for a wrapper than for a filler leaf, as it is flimsy and has not sufficient body for a filler leaf. If a special effort were made to produce a fine, thin wrapper leaf it would probably prove profitable, but at present it is only recognized that these soils produce a comparatively light yield, which will not bring an advanced price, and consequently they are regarded as poor tobacco soils. Uncleared forest land in this formation does not bring a high price, for the cost of clearing is considerable, as well as are the subsequent expense and labor necessary to make the soil productive.

The following table gives the mechanical analyses of typical samples of the Hagerstown shale-loam soils:

Mechanical analyses of Hagerstown shale loam.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
4983	Brunnerville, one-half mile S.	0 to 10 inches	7.68	10.94	5.16	3.70	3.64	8.22	47.90	12.35
4985	Kissel Hill	Yellow shaly loam, 0 to 10 inches.	6.70	16.25	7.72	2.56	5.11	4.87	32.06	24.92

CECIL MICA LOAM.

This formation occupies the greater part of Conestoga and the southern part of Pequea townships. The formation also occupies a small portion in the southwestern part of West Lampeter Township. The surface is characterized by high rolling country along the Pequea and Conestoga creeks and Susquehanna River. Long ridges and steep-sided valleys form a feature of the topography rather than rounded hills. Along the Susquehanna the banks are high, bold bluffs, heavily timbered, rising considerably over 100 feet above the river bed. The rocks from which these soils were derived belong to the older system of rocks, whose origin have to the present been an unsolved problem. They form a part of the complex system of rocks which constitute the Piedmont plateau of the Atlantic Coast States.

The rocks consist of a fine grayish mica schist, which weathers into heavy sandy loams of a yellowish color, completely filled with particles of fine muscovite mica or isinglass, as it is commonly called. The subsoil has a lighter yellow color, and contains a greater percentage of small mica flakes. At an average depth of 30 inches the subsoil grades into partially decomposed schist and loose stones. These soils are not strong enough to stand hard farming, but with careful management they can be made to produce fair crops of corn, oats, wheat, and grass. When the season is just right they compare favorably with the better class of soils found in the county. Care must always be taken on the steep slopes to prevent them from being ruined for cultivation by gullies. Generally, the surface of this formation is free from stones or bowlders, except on the narrow crests of the steepest ridges, where from 10 to 40 per cent of stones is noticed. Although the rocks from which these soils are derived do not weather rapidly, still they are soft, and along the roadways they cut deeply, and most of the roads in the area of Cecil mica loam are several feet below the surface of the fields. This is a characteristic feature of the roads in similar soil areas of the Piedmont Plateau whether these rocks occur in Pennsylvania or in one of the States hundreds of miles farther south.

Many peach orchards are seen on the steep hill slopes of this formation, and, judging from the present success, there seems no reason why the cultivation of peaches should not be developed with a fair degree of profit to the grower. Some tobacco is raised, but the crop is not so extensively cultivated as on the areas farther north in the county. The tobacco is said to be of fine grade, but as the yield is rather light the raising of tobacco has not received much attention. The newly cleared fields produce a fair wrapper tobacco, but after the lands have become somewhat worn they grow a leaf better adapted to filler purposes.

The mechanical analyses of typical samples are given in the following table:

Mechanical analyses of Cecil mica loam.

No..	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4988	Baumgarden, 1 mile NE.	0 to 10 inches	3.97	7.47	4.20	2.19	13.94	29.72	32.00	7.53
4986	Conestoga Center, 1 mile E.	0 to 10 inches	4.10	4.53	2.87	3.20	11.48	30.73	29.79	13.08
4989	Subsoil of 4988	10 to 30 inches	3.69	5.68	4.51	2.65	15.05	25.90	32.81	9,85
4987	Subsoil of 4986	Yellow micaceous loam, 10 to 40 inches.	3.15	10.65	6.79	3.24	17.53	18.70	25.28	14.91

MANOR STONY LOAM.

An area of about 5 square miles occurs in the southwestern part of Manor Township. On its eastern border it comes in contact with the

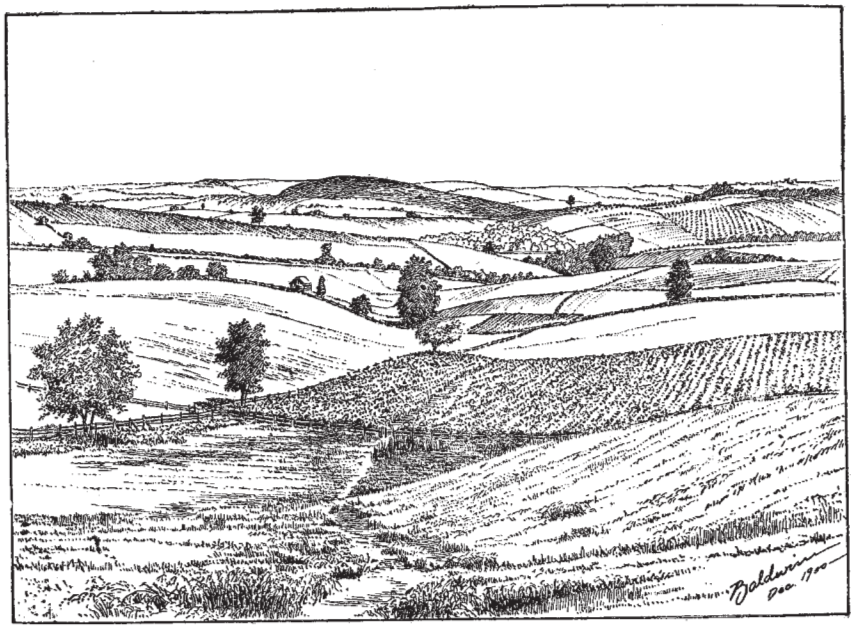


FIG. 2.—Rolling character of country in Manor stony loam in the southern part of the area.

large area of Conestoga loam; along the southern border is Conestoga Creek, while along the entire western boundary is the broad Susquehanna River. The topography of this formation is quite similar to that of the Cecil mica loam, except that the hills along Conestoga

Creek and the Susquehanna are slightly higher. Along the Susquehanna the hills rise abruptly to an elevation of 200 feet above the river bed. (Fig. 2.)

The soils are derived from a fine schistose rock in which there has been a great development of chlorite—a green, iron-bearing mineral. These rocks, like the schists from which the Cecil mica loam is derived, belong to the series of greatly metamorphosed rocks which constitute to such a great extent the area of the Piedmont Plateau. The chlorite schists of this formation weather into soils which resemble somewha the Conestoga loam and the Cecil mica loam. In texture they are midway between them. The surface soil to a depth of 8 inches is a yellowish red loam possessing to a marked degree the greasy feel so characteristic of Conestoga loam. The subsoil contains considerably more clay and has a more decided reddish color than the surface soil. A constant feature of this formation is the amount of stones scattered over the surface and mingled with the soil and subsoil. These stones are the weathered beds of schist, and are from 3 to 10 inches in length, of a reddish color, and club-shaped. The amount of stones on the surface varies from 20 to 60 per cent, the greatest number being on the highest hills and steepest slopes. At an average depth of 30 inches the subsoils grade into a loose mass of broken schist fragments. Many successful peach orchards are seen on the hillsides in this formation. Fair crops of corn, wheat, grass, oats, rye, and potatoes are raised, but these soils are not considered as safe as the Conestoga loam, which they somewhat resemble. Tobacco is not extensively grown, but dealers say that they have seen crops of tobacco from this section which compared favorably with the best grown in the county. Lands in this formation do not bring high prices compared with the more fertile valley soils, but there are many prosperous farms in this part of Manor Township, and a fair profit can be realized from cultivating these soils.

The mechanical analyses of a few typical samples are given in the following table:

Mechanical analyses of Manor stony loam.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4992	Creswell, one-half mile W.	0 to 10 inches	7.80	1.74	1.32	1.15	8.63	21.01	48.94	9.86
4990	Pittsburg, 1 mile W.	do	5.34	6.60	2.61	1.70	8.49	16.93	43.37	15.33
4991	Subsoil of 4990	10 to 30 inches	4.32	5.10	3.07	1.68	13.06	26.52	28.83	17.69
4993	Subsoil of 4992	do	5.44	2.50	1.39	1.04	7.65	17.84	43.55	20.12

HEMPFIELD STONY LOAM.

Eight small areas of the Hempfield stony loam are located in the western part of the county surveyed. The largest of these areas does not cover more than one-half square mile, while the combined extent of the several areas does not exceed more than 2 square miles. The occurrence of the areas of this formation is in the limestone valleys, and they merely form slight ridges or rocky knobs, which rise but a short distance above the general level of the valley floor. The soil is derived from the decay of a fine-grained, dark-blue rock, which is very hard and is locally known as ironstone. The rock is doubtless an intrusive diabase of Mesozoic age which has cut across the limestones in this section of the country. The soils derived from this rock always have a deep-red color, quite distinct from the red color of the clays derived from the weathering of limestones. The top soil is a heavy, red sandy loam to a depth of 10 or 12 inches, under which is found a heavy, red clay loam. In texture this soil is quite similar to Hagerstown clay loam. The distinguishing characteristics are the deep-red color and the large amounts of rounded stones. Formerly many of the fields of this formation were strewn with large, well-rounded boulders from 1 to 3 feet in diameter. These have all been removed, but the surface is still thickly strewn with the rounded "ironstones" varying from 2 to 6 inches in diameter. The percentage of stones on the surface varies from 30 to 60 per cent. The areas of this soil formation are so limited in extent that it is difficult to estimate their productiveness. They rank as heavy, strong clay soils, and in large fields, where they occur along with the limestone soils, little or no difference is seen between the crop on the respective soils. The large amount of stones on the surface makes them difficult to cultivate, and for this reason they are not held in high esteem.

DONEGAL GRAVELLY LOAM.

Donegal gravelly loams occur as low, poorly preserved terraces along the Susquehanna River in East Donegal, West Hempfield, and Manor townships. These terraces usually extend back one-half mile from the river bank and gradually merge into the rolling limestone areas. The only place where they are found is where the river cuts across the limestone beds. In all other places the rocks have been too hard and resistant, and steep, bold cliffs occur with no room for the formation of terraces. They rise from 10 to 30 feet above the river level, depending upon the amount of erosion they have undergone subsequent to their deposition. Occasionally there are remnants of two formerly well-defined terraces. Rowenna, Marietta, Columbia, Shultztown, and Washington Borough are all situated on these terraces. The terrace in West Hempfield Township is completely covered by the city of Columbia.

These terraces were doubtless deposited by the Susquehanna River

during the time when the northern part of the county was covered by masses of melting ice at the close of the glacial epoch. They are composed of sand and gravel in constantly changing proportions, depending on the strength of the currents of the stream at the time they were deposited. The small streams flowing across these terraces have considerably altered their surface until they appear as a series of small rounded hills extending along the river for miles.

The soils of these eroded terraces change rapidly in short distances, according to the character of the materials from which they are derived. A field of a few acres may have a gravelly soil composed of sand mixed with well-rounded gravel from 1 to 4 inches in diameter. A few hundred feet distant the soil is a reddish-brown sand, not unlike the soils of the Connecticut River Valley, and so these soils change from a sandy to a gravelly nature so rapidly that it is difficult to ascribe any exact or constant character to this formation. They constitute a class of sandy and gravelly soils, which have no counterpart in the other portions of the county. For general agricultural purposes they have little value, but for growing truck or crops which need a light porous soil they far excel any of the soil formations yet described. Above Marietta they produce fine crops of corn, tomatoes, strawberries, melons, sweet potatoes, peas, beans, etc. For producing a fine, thin leaf, suitable for wrapping and binding cigars, these soils are far ahead of any soils which occur in the county, and good crops from these soils equal in quality the tobacco grown in Connecticut. The larger islands in the Susquehanna also have sandy soils and produce equally fine crops of tobacco. This tobacco commands a good price, and a large amount is grown on these alluvial lands and the larger islands in the river.

The table following gives the mechanical analyses of soils and subsoils of the Donegal gravelly loam formation:

Mechanical analyses of Donegal gravelly loam.

[Fine earth.]

No.	Locality	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
4996	Washington Borough	0 to 10 inches	1.96	.00	2.56	27.86	15.16	36.48	11.84	3.27
4994	Washington Borough 1 mile S.	do	4.34	------	Tr.	12.13	8.33	45.39	25.23	3.86
4997	Subsoil of 4996	10 to 30 inches	1.98	------	2.58	26.18	15.27	35.03	13.35	5.48
4995	Subsoil of 4994	do	2.12	------	Tr.	18.74	11.44	41.00	20.25	6.20
4999	Marietta (north of)	10 to 24 inches	2.68	Tr.	2.16	6.02	4.02	21.18	50.24	12.71

ACKNOWLEDGMENTS.

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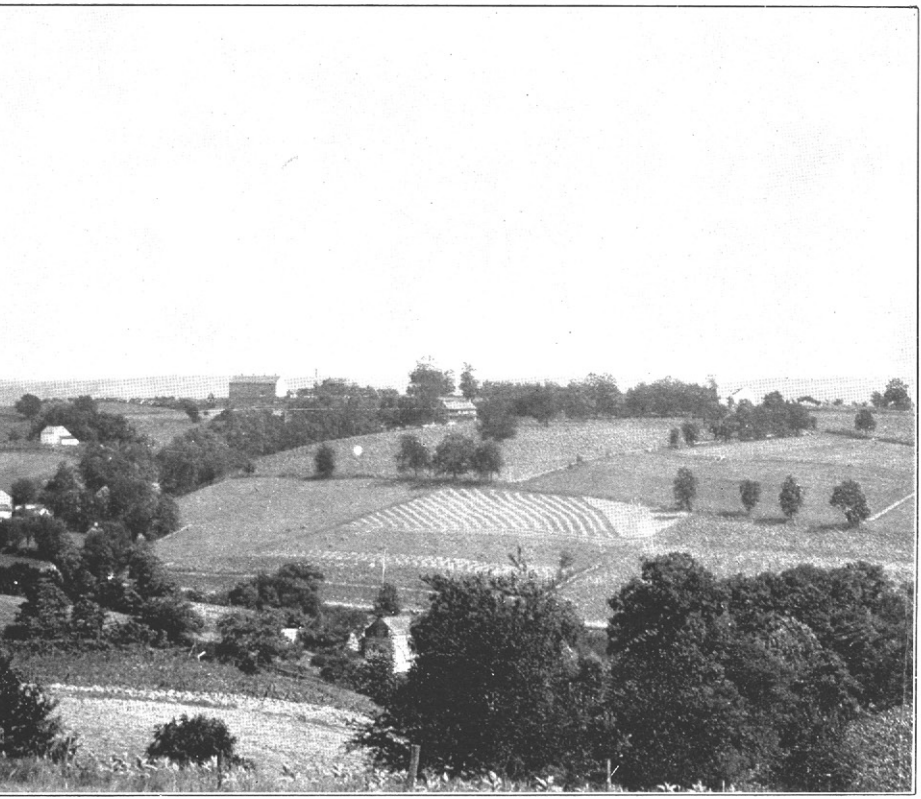

CHARACTER OF THE COUNTRY IN CECIL MICA LOAM AREA.

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U. S. DEPT OF AGRICULTURE
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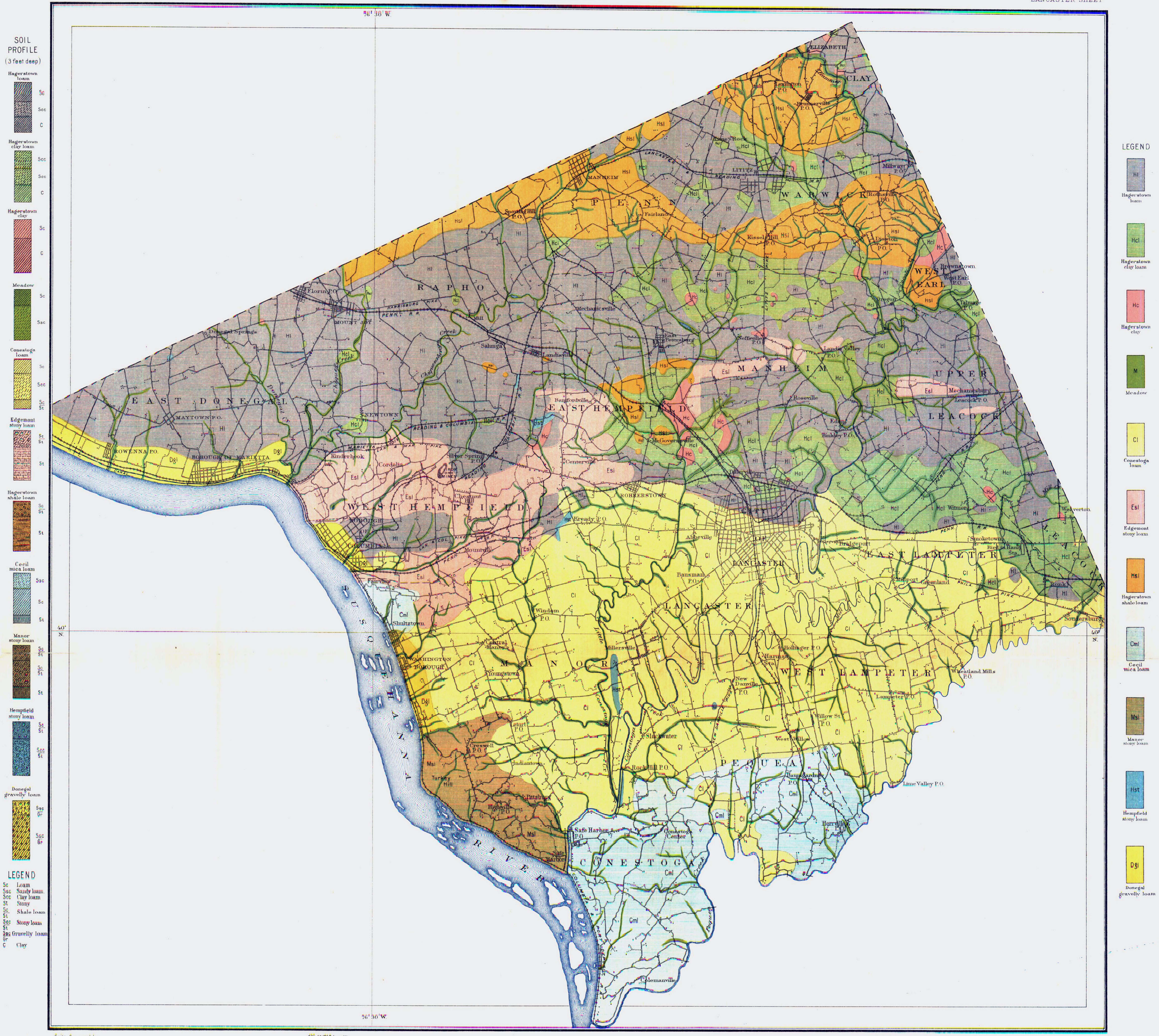
SOIL MAP

PENNSYLVANIA
LANCASTER SHEET



Soils Surveyed by
Clarence W. Dorsey
1900

Scale 1 in = 1 mile

Field Operations
Division of Soils
1900